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Saito

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(54) **NETWORK SYSTEM, INTERNAL SERVER, TERMINAL DEVICE, STORAGE MEDIUM AND PACKET RELAY METHOD**

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(30) **Foreign Application Priority Data**

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(51) **Int. Cl.**

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G06F 17/00	(2006.01)
H04L 29/06	(2006.01)

(52) **U.S. Cl.** **726/11**; 713/153; 713/154; 709/223

(58) **Field of Classification Search** 726/11
See application file for complete search history.

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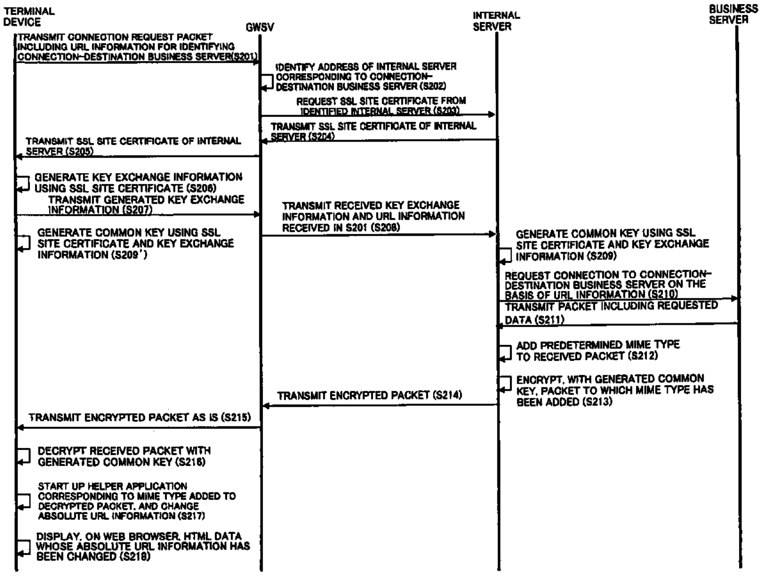
(57) **ABSTRACT**

A network system has a firewall that connects an external network and an internal network. A terminal device is provided on the external network. An application server is provided on the internal network and provides data to the terminal device based on a request from the terminal device. An external server is provided on a DMZ of the firewall or on the external network, and relays communication between the terminal device and the application server based on the request from the terminal device through an internal server. The internal server is provided on the internal network, and relays communication between the external server and the application server. The internal server has an encrypting unit that encrypts the packet in such a manner that an encrypted packet is able to be decrypted only by the terminal device.

9 Claims, 4 Drawing Sheets


TERMINAL DEVICE
GWSV
INTERNAL SERVER
BUSINESS SERVER
TRANSMIT CONNECTION REQUEST PACKET INCLUDING URL INFORMATION FOR IDENTIFYING CONNECTION-DESTINATION BUSINESS SERVER(S201)
IDENTIFY ADDRESS OF INTERNAL SERVER CORRESPONDING TO CONNECTION-DESTINATION BUSINESS SERVER (S202)
REQUEST SSL SITE CERTIFICATE FROM IDENTIFIED INTERNAL SERVER (S203)
TRANSMIT SSL SITE CERTIFICATE OF INTERNAL SERVER (S204)
TRANSMIT SSL SITE CERTIFICATE OF INTERNAL SERVER (S205)
GENERATE KEY EXCHANGE INFORMATION USING SSL SITE CERTIFICATE (S206)
TRANSMIT GENERATED KEY EXCHANGE INFORMATION (S207)
TRANSMIT RECEIVED KEY EXCHANGE INFORMATION AND URL INFORMATION RECEIVED IN S201 (S208)
GENERATE COMMON KEY USING SSL SITE CERTIFICATE AND KEY EXCHANGE INFORMATION (S209')
GENERATE COMMON KEY USING SSL SITE CERTIFICATE AND KEY EXCHANGE INFORMATION (S209)
REQUEST CONNECTION TO CONNECTION-DESTINATION BUSINESS SERVER ON THE BASIS OF URL INFORMATION (S210)
TRANSMIT PACKET INCLUDING REQUESTED DATA (S211)
ADD PREDETERMINED MIME TYPE TO RECEIVED PACKET (S212)
ENCRYPT, WITH GENERATED COMMON KEY, PACKET TO WHICH MIME TYPE HAS BEEN ADDED (S213)
TRANSMIT ENCRYPTED PACKET (S214)
TRANSMIT ENCRYPTED PACKET AS IS (S215)
DECRYPT RECEIVED PACKET WITH GENERATED COMMON KEY (S216)
START UP HELPER APPLICATION CORRESPONDING TO MIME TYPE ADDED TO DECRYPTED PACKET, AND CHANGE ABSOLUTE URL INFORMATION (S217)
DISPLAY, ON WEB BROWSER, HTML DATA WHOSE ABSOLUTE URL INFORMATION HAS BEEN CHANGED (S218)

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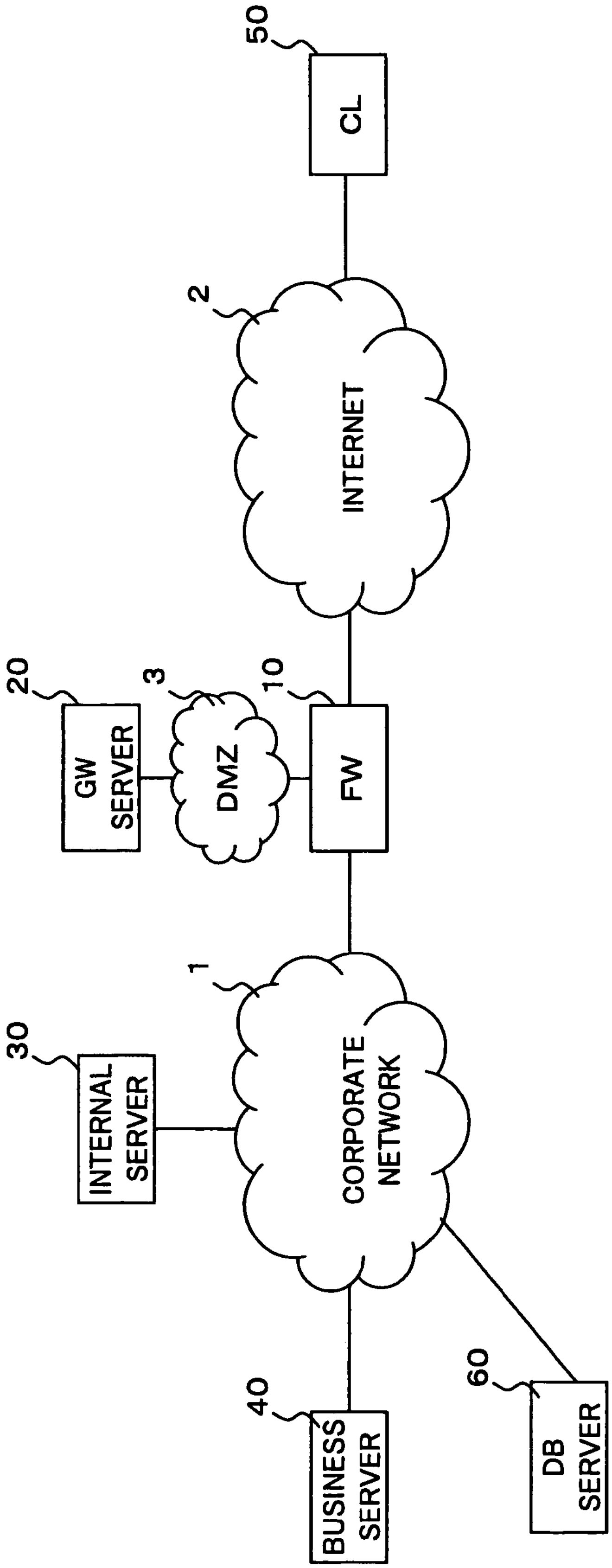

50
CL
2
INTERNET
20
GW SERVER
3
DMZ
10
FW
30
INTERNAL SERVER
1
CORPORATE NETWORK
40
BUSINESS SERVER
60
DB SERVER

Fig. 1

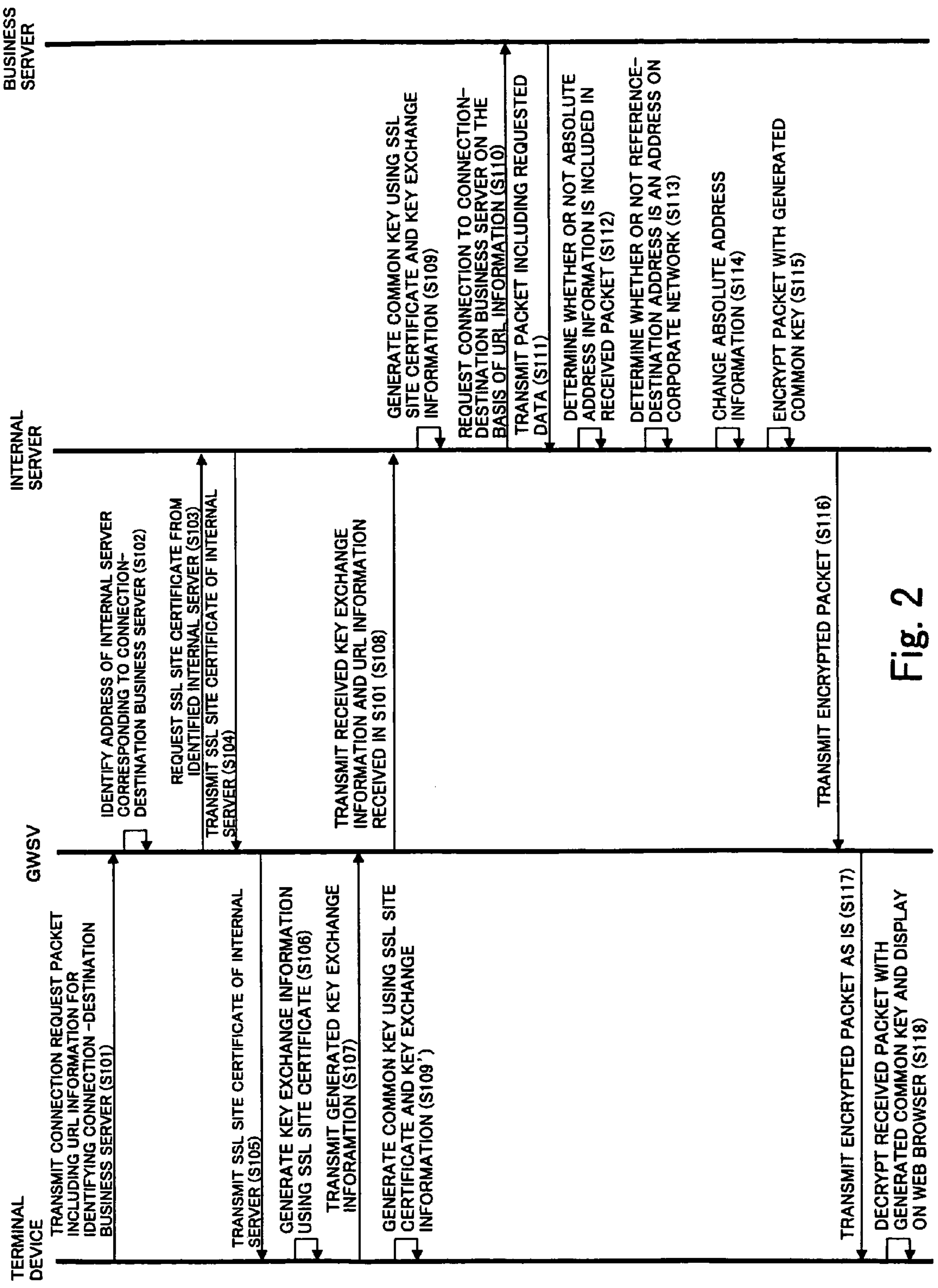
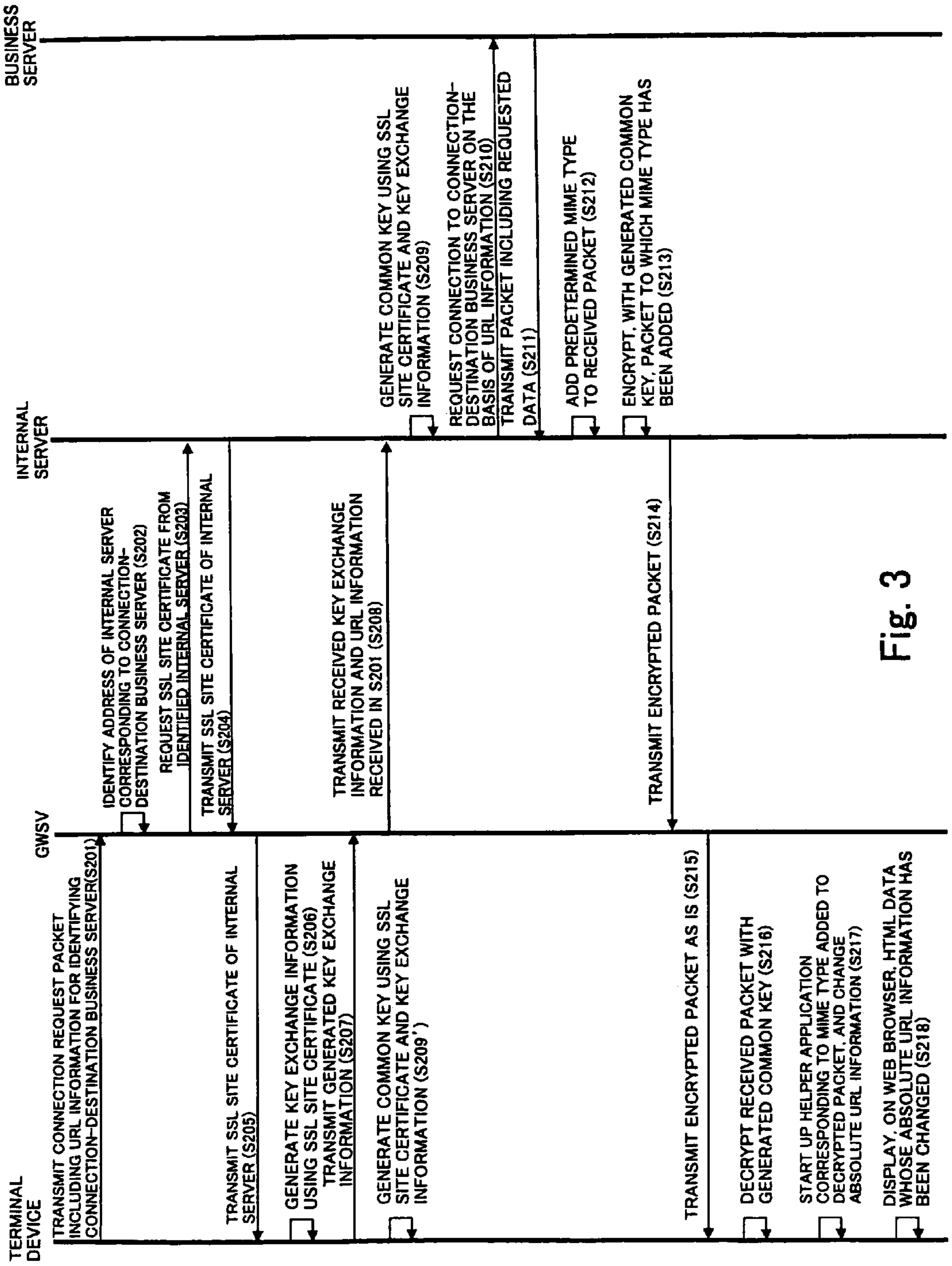

TERMINAL DEVICE
GWSV
INTERNAL SERVER
BUSINESS SERVER
TRANSMIT CONNECTION REQUEST PACKET INCLUDING URL INFORMATION FOR IDENTIFYING CONNECTION -DESTINATION BUSINESS SERVER (S101)
IDENTIFY ADDRESS OF INTERNAL SERVER CORRESPONDING TO CONNECTION-DESTINATION BUSINESS SERVER (S102)
REQUEST SSL SITE CERTIFICATE FROM IDENTIFIED INTERNAL SERVER (S103)
TRANSMIT SSL SITE CERTIFICATE OF INTERNAL SERVER (S104)
TRANSMIT SSL SITE CERTIFICATE OF INTERNAL SERVER (S105)
GENERATE KEY EXCHANGE INFORMATION USING SSL SITE CERTIFICATE (S106)
TRANSMIT GENERATED KEY EXCHANGE INFORAMTION (S107)
TRANSMIT RECEIVED KEY EXCHANGE INFORMATION AND URL INFORMATION RECEIVED IN S101 (S108)
GENERATE COMMON KEY USING SSL SITE CERTIFICATE AND KEY EXCHANGE INFORMATION (S109')
GENERATE COMMON KEY USING SSL SITE CERTIFICATE AND KEY EXCHANGE INFORMATION (S109)
REQUEST CONNECTION TO CONNECTION-DESTINATION BUSINESS SERVER ON THE BASIS OF URL INFORMATION (S110)
TRANSMIT PACKET INCLUDING REQUESTED DATA (S111)
DETERMINE WHETHER OR NOT ABSOLUTE ADDRESS INFORMATION IS INCLUDED IN RECEIVED PACKET (S112)
DETERMINE WHETHER OR NOT REFERENCE-DESTINATION ADDRESS IS AN ADDRESS ON CORPORATE NETWORK (S113)
CHANGE ABSOLUTE ADDRESS INFORMATION (S114)
ENCRYPT PACKET WITH GENERATED COMMON KEY (S115)
TRANSMIT ENCRYPTED PACKET (S116)
TRANSMIT ENCRYPTED PACKET AS IS (S117)
DECRYPT RECEIVED PACKET WITH GENERATED COMMON KEY AND DISPLAY ON WEB BROWSER (S118)

Fig. 2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START UP HELPER APPLICATION CORRESPONDING TO MIME TYPE ADDED TO DECRYPTED PACKET, AND CHANGE ABSOLUTE URL INFORMATION (S217)
DISPLAY, ON WEB BROWSER, HTML DATA WHOSE ABSOLUTE URL INFORMATION HAS BEEN CHANGED (S218)

Fig. 3

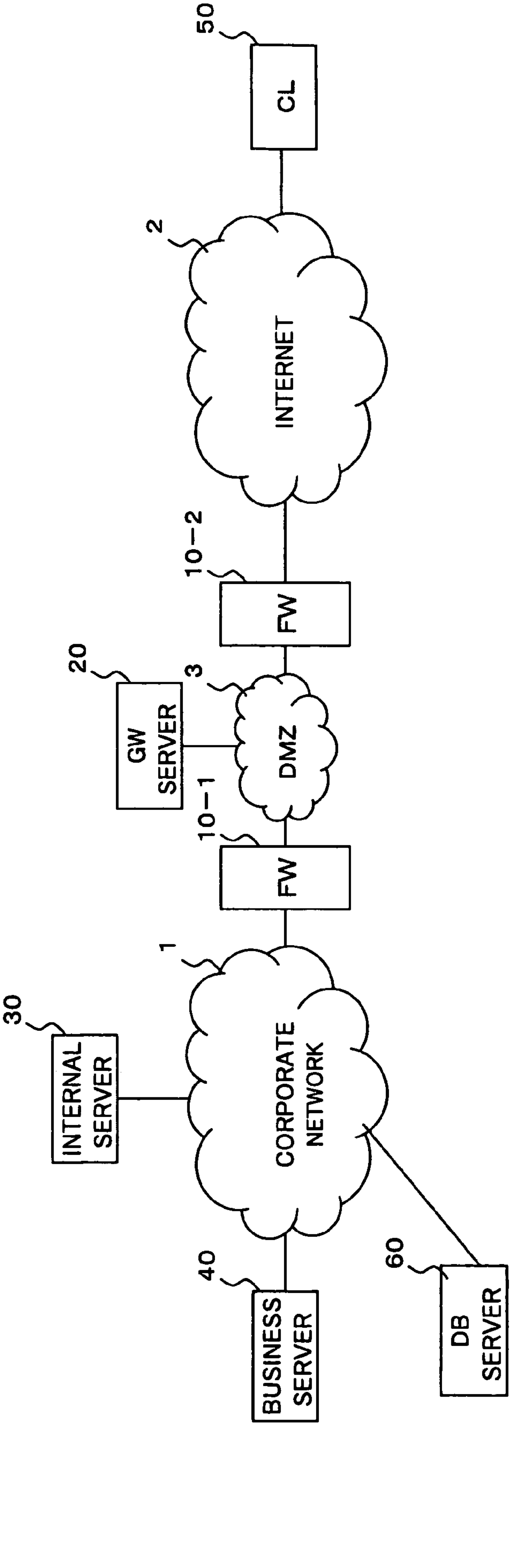
30
INTERNAL SERVER
40
BUSINESS SERVER
60
DB SERVER
1
CORPORATE NETWORK
10−1
FW
20
GW SERVER
3
DMZ
10−2
FW
2
INTERNET
50
CL

Fig. 4

NETWORK SYSTEM, INTERNAL SERVER, TERMINAL DEVICE, STORAGE MEDIUM AND PACKET RELAY METHOD

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a network system where a terminal device on an external network and an application server on an internal network communicate with each other via a firewall connected between the external network and the internal network.

2. Description of the Related Art

In accompaniment with the spread of the Internet environment, the number of companies is increasing whose internal network is connected to an external network such as the Internet so that data can be transmitted to and received from the company via e-mail or the Web (HTTP).

Environments in which external networks like the Internet can be remotely accessed using a wireless LAN or PHS are also rapidly becoming more widespread.

In the midst of such environments, the demand has arisen for company employees to want to access the internal network of their own company from places outside the company. Conventionally, as means for responding to this demand, a dial-up facility has been prepared in the company. However, because the speed of dial-up connections is slow and costs are incurred, recently networks called VPN (Virtual Private Network) and SSL-VPN (Secure Socket Layer-Virtual Private Network) have come to be used to enable a user to connect to the internal network of the user's company from the Internet. In this case, for example, a server called a reverse proxy, which is disposed at the node between the internal network, such as a corporate LAN, and the Internet, and which relays access from the external network to a device in the network such as a Web server, is also sometimes used.

A VPN is a network where a private network is constructed on a shared network (e.g., the Internet). In a VPN, an encrypted channel is secured between a point A and a point B connected over the Internet to create a condition as if the two points were connected through a dedicated line. Thus, when a personal client PC connects to the Internet and accesses a VPN device disposed in the DMZ (demilitarized zone) of the company firewall, the personal client PC and the VPN device communicate with each other using an encrypted protocol, so that the user can safely use the internal network as if the client PC were connected to the network inside the company. However, in this case, it is necessary to dispose a VPN device (server) in the company and to dispose client software in the client PC.

An SSL-VPN is a network which attempts to provide functions similar to a VPN without installing special client software in the client PC in order to more easily access the resources in the company. In order to access the data within the company, ordinarily a Web browser pre-installed in the client PC is used. The method of accessing the data is limited to the range accessible with the Web browser, but because various corporate applications have recently come to be realized with a Web base, this often does not become that much of a problem from a practical standpoint. Thus, SSL-VPNs have been gaining attention particularly recently. Also, in contrast to a VPN which, when a client PC is connected in the VPN, can create a condition as if the client PC were connected directly to the corporate network, an SSL-VPN can be set so that only a predetermined Web server can be accessed even if connected. Thus, this is preferable from the standpoint of security.

It is common for a corporate network to be connected to an external network via a firewall in order for the corporate network to be protected from unauthorized access from the Internet or the like. With a firewall, the kinds of packets passed between the Internet and the corporate network can be set in detail. It is common for the firewall to be set so that common protocols such as HTTP and HTTPS are allowed to pass from the corporate network to the Internet and so that other protocols do not pass from the Internet to the corporate network.

However, because both VPNs and SSL-VPNs are networks for accessing the corporate network from the Internet, it is necessary to change the firewall settings to allow access to the corporate network from the Internet. There are also numerous cases where a company decides that changing the firewall settings is not permissible because doing so would pose a security threat.

In this regard, the SWANStor® access method of Japanese Patent Application Laid-Open Publication (JP-A) No. 2002-140239 has been devised. This invention is configured by two servers: an internal server within a corporate network, and the Internet or an external server disposed in the DMZ of a firewall. Connection requests are invariably sent from the internal server to the external server. Specifically, connection requests continue to be periodically sent from the internal server to the external server, to create a state where the servers are pseudo-continuously connected. Thus, the corporate network can be accessed from the Internet ordinarily without having to change the firewall settings.

Thus, when a client PC on the Internet connects to the external server and sends a request to connect to the corporate server, the external server transmits the request from the outside user to the internal server as a response to the connection request from the internal server.

Because the internal server is disposed on the corporate network, the internal server can normally access the corporate server. The internal server connects to the corporate server and sends the returned result to the external server. As a result, the external server sends internal data to the outside client PC, whereby the outside client PC can access the corporate server.

Moreover, a method has been proposed where data can be safely transmitted on a communication path between a client PC of a user and an external server, and between an external server and an internal server, using an encryption protocol called SSL (Secure Socket Layer), because the data is encrypted. Thus, an outside company employee can safely access the corporate server using a client PC, without the need for the firewall settings to be changed.

With this method, the problem arises that "absolute address information for identifying a specific server" is included in the data returned from the corporate server.

Namely, when address information identifying a specific corporate server, such as "http://intra.foo.var.co.jp/index.htm", is included in the data returned from the internal server, and when the user selects that address information, the corporate server naturally cannot be directly accessed from the Internet. Thus, the problem arises that the error message "Server cannot be located" is displayed in the Web browser.

In this regard, processing to change the absolute address has already been proposed. Namely, when absolute address information is included in data to be transferred to the outside, the absolute address information is changed to address information passing through the external server. For example, assuming that the address of the external server is "https://outside.abc.net", the address is changed to "https://outside-.abc.net/intra.php?="http://intra.foo.var.co. jp/index.htm". When the address is changed in this manner, the external server receives that request, interprets the address designated by the argument to be the address to the corporate server, and sends a connection request to the corporate server.

However, even with this method, the following problems arise.

Namely, in the above method, the external server and the internal server, and the external server and the client PC, are connected using SSL, but the data sent from the internal server to the external server is temporarily decrypted by the external server, and is then again encrypted by the external server and sent to the client. Thus, unencrypted data is momentarily present on the external server.

When unencrypted data is present on the external server, for example, when the external server is operated on a service site that an independent service provider operates and that external server is shared by internal servers of several companies, confidential data of those companies that has not been encrypted remains on the service site, even if momentarily. From the standpoint of security, this leads to an undesirable situation because safety with respect to leakage of the data is entrusted to the management of the operating company.

SUMMARY OF THE INVENTION

The present invention has been made in view of the above circumstances and provides a data access method allowing data to be accessed from an external network without the need for the firewall settings to be changed, where data exchanged between an external network and an internal network is not left on an external server in an unencrypted state.

According to an aspect of the present invention there is provided a network system comprising a firewall connected between an external network and an internal network; a terminal device present on the external network; an application server present on the internal network, the application server configured to supply desired data to the terminal device in response to a request from the terminal device; an external server present on a DMZ of the firewall or on the external network, the external server configured to receive a request from the terminal device to connect to the application server and relay communication between the terminal device and the application server; and an internal server present on the internal network, the internal server configured to relay communication between the external server and the application server, with communication between the external server and the internal server being permitted only by a session established on the basis of a connection request from the internal server to connect to the external server, and with the external server relaying the request from the terminal device for connection to the application server as a response to the connection request from the internal server, wherein the internal server includes receiving unit that receives a packet for the terminal device from the application server; encrypting unit arranged to conduct, with respect to the received packet, encryption that can be decrypted by only the terminal device; and transmitting unit arranged to transmit the encrypted packet to the external server via the firewall, and wherein the external server includes receiving unit arranged to receive the packet encrypted by the internal server; and transmitting unit arranged to transmit intact the received encrypted packet to the terminal device without decrypting the encrypted packet.

According to the present invention, the internal server conducts, with respect to the received packet destined for the terminal device, encryption that can be decrypted only by the terminal device, and transmits the encrypted packet to the external server via the firewall. The external server receives the packet encrypted by the internal server and transmits, as is to the terminal device, the encrypted packet without decrypting the encrypted packet. Thus, in the external server that is present on the DMZ of the firewall or on the external network and which general users can access, the packet from the internal network reaches the terminal device on the external network without being inadvertently decrypted. Therefore, security can be improved over cases where the packet is temporarily decrypted by the external server.

BRIEF DESCRIPTION OF THE DRAWINGS

Various exemplary embodiments of a system and method of the present invention will be described in detail below with reference to the accompanying drawings, in which:

FIG. **1** is a diagram showing the network configuration of a network system in first and second embodiments;

FIG. **2** is a diagram showing a procedure where an Internet terminal device communicates with a business server on a corporate network in the first embodiment;

FIG. **3** is a diagram showing a procedure where the Internet terminal device communicates with the business server on the corporate network in the second embodiment; and

FIG. **4** is a diagram showing an example of a network configuration applicable to the network system of the first and second embodiments.

DESCRIPTION OF THE EMBODIMENTS

A first embodiment of the invention will now be described using the drawings.

FIG. **1** is a diagram showing the network configuration of a network system of the first embodiment. The network system of the first embodiment is configured by three networks—a corporate network **1**, the Internet **2** and a demilitarized zone (DMZ) **3**—centered around a firewall **10**. This system is mainly for accessing a business server **40** on the corporate network **1** from a terminal device **50** on the Internet **2**, so that the terminal device **50** can receive desired services from the business server **40**.

The corporate network **1** in FIG. **1** is an internal network accessible only by specific users. The Internet **2** is an external network accessible by general users. The DMZ **3** is a network that is isolated from, and relays communication between, the corporate network **1** and the Internet **2**.

The firewall **10** is a security device which ensures that only the necessary services are provided to the user by trapping all connection request packets with respect to other networks transmitted from the corporate network **1** and the Internet **2** and arbitrarily prohibiting or allowing those packets to pass, security. The firewall **10** of the first embodiment is set to allow connection request packets from the corporate network **1** to an outside network (the DMZ **3**, the Internet **2**) if the protocol used is HTTP or HTTPS, and to prohibit connection request packets from an outside network to the corporate network **1** with respect to all protocols.

A gateway (GW) server **20** is disposed on the DMZ **3**. The GW server **20** is a relay device that receives packets from the terminal device **50** on the Internet **2** destined for the corporate network **1** and transfers those packets to the corporate network **1**, and which receives packets from the corporate network **1** destined for the terminal device **50** and transfers those packets to the terminal device **50**. In the first embodiment, an example is described where the GW server **20** is disposed on the DMZ **3**, but the GW server **20** may also be disposed on a network other than the corporate network **1**, such as the Internet **2**.

An internal server **30** is disposed on the corporate network **1**. The internal server **30** is a relay device that receives, from the GW server **20** via the firewall **10**, packets from the terminal device **50** on the Internet **2** destined for the corporate network **1** and transfers those packets to the business server **40** designated by the terminal device **50**, and which receives packets from the business server **40** destined for the terminal device **50** and transfers those packets to the GW server **20** via the firewall **10**.

The business server **40** is an application server that provides desired Web-based services to the terminal device **50** and the like.

The terminal device **50** is a common personal computer, and is a client terminal device connected to the Internet **2** wirelessly or with a cable.

A database (DB) server **60** is one communication device that plays a supplementary role with respect to the services that the business server **40** provides. For example, the DB server **60** has a reference-destination address displayed on a Web screen that the business server **40** provides, and when the terminal device **50** accesses that reference-destination address, the DB server **60** provides additional data to the terminal device **50**.

When the terminal device **50** on the Internet **2** accesses the business server **40** on the corporate network **1** in the network system configured in this manner, the terminal device **50** communicates with the business server **40** via the GW server **20** and the internal server **30**.

However, as described above, the transmission of connection request packets from the GW server **20** to the internal server **30** is prohibited by the settings of the firewall **10**. Thus, when the GW server **20** receives a request from the terminal device **50** to connect to the business server **40**, that connection request packet is destroyed by the firewall **10** even if the GW server **20** transmits the connection request packet to the internal server **30** in order to establish a session with the relay-destination internal server **30**. Thus, the terminal device **50** cannot communicate with the business server **40** unless something else is done.

Thus, in the first embodiment, the GW server **20** and the internal server **30** are configured so that a session between the GW server **20** and the internal server **30** is continually maintained by a connection request from the internal server **30**, so that the internal server **30** can pseudo-receive the connection request packet from the GW server **20**. The technology for ensuring that the internal server **30** can pseudo-receive the connection request packet from the GW server **20** without changing the settings of the firewall **10** may be realized by, for example, the technology described in JP-A No. 2002-140239.

In the network system configured in this manner, when absolute address information for accessing a communication device such as the DB server **60** present on the corporate network **1** is included in the packet that the business server **40** provides in response to the request from the terminal device **50**, the connection to that communication device ends up being denied as a result of the settings of the firewall **10** even if the terminal device **50** tries to directly access the communication device on the corporate network **1** on the basis of that absolute address information.

In order to circumvent this situation, when absolute address information is included in the packet, the absolute address information has conventionally been rewritten, in the GW server **20** relaying communication between the terminal device **50** and the business server **40**, to absolute address information via the GW server **20**, so that attempts by the terminal device **50** to directly connect to the reference-destination communication device described in the absolute address information are prevented.

However, with this method, there is the potential for security problems to arise because even if the packet sent from the internal server **30** to the GW server **20** is encrypted in the internal server **30**, the packet ends up being temporarily decrypted in the GW server **20** present on the DMZ **3** that terminal devices of general users on the Internet can access.

Thus, in the first embodiment, the internal server **30** changes the absolute address information and encrypts the packet so that the packet can only be decrypted by the terminal device **50**. Specifically, processing is conducted in each device so that the internal server **30** and the terminal device **50** are pseudo-directly connected by SSL on the communication path where the internal server **30** and the terminal device **50** are connected via the GW server **20**. Thus, in the GW server **20**, it becomes unnecessary to decrypt the packet because the absolute address information is changed, and security can be improved.

The procedure where the terminal device **50** on the Internet **2** communicates with the business server **40** on the corporate network **1** will be described in further detail below using FIG. **2**. In the first embodiment, a URL is used as identification information for clearly identifying each device on the network. Specifically, the URL of the GW server **20** is "https://gw.foo.net," the URL of the internal server **30** is "https://srv.bar.co.jp," and the URL of the business server **40** is "https://intra.abc.bar.co.jp."

Referring now to FIG. **2**, first, the terminal device **50** transmits a connection request packet to the GW server **20** in order to initiate communication with the business server **40** (S**101**). In order to identify the connection-destination business server, "https://gw.foo.net/http://intra.abc.bar.co.jp" is described as URL information in the connection request packet.

The GW server **20** waits to receive the connection request packet from the terminal device **50** on the Internet **2**. Then, when the GW server **20** receives the connection request packet from the terminal device **50**, the GW server **20** references the information following its own address in the URL information described in the packet (i.e., in the case of this example, "http://intra.abc.bar.co.jp," which is described after "https://gw.foo.net") to identify the address of the internal server **30** with respect to the business server **40** (S**102**). The address of the internal server **30** may be identified in accordance with the following rule, for example. Namely, the address "srv.bar.co.jp", where the specific host name "srv" is added to the domain name "bar.co.jp", is identified as the address of the internal server **30**. The addresses of internal servers with respect to each business server may also be associated and registered in advance in a database on the GW server **20**, **50** that when the database is referenced in each case, the address of the internal server with respect to the connection-destination business server is identified. After the GW server **20** identifies the address of the internal server **30** in this manner, the GW server **20** requests an SSL site certificate with respect to that internal server **30** (S **103**).

The internal server **30** whose SSL site certificate has been requested transmits its own SSL site certificate to the GW server **20** (S**104**). It will be noted that the network system may also be configured so that the SSL site certificate of the internal server **30** is registered in advance in the memory of the GW server **20**, so that the GW server **20** does not request the SLL site certificate with respect to the identified internal server **30** in each case. Thus, the URL information of the server serving as the target is embedded in the SSL site certificate, and whether or not the URL information in the

SSL certificate matches the URL to which the terminal device **50** is connected is checked by the terminal device **50**. It will be assumed that the URL information of the GW server **20** is embedded in advance in the SSL certificate used here (however, it will be assumed that the secret key with respect to the site certificate is managed only by the internal server **30** that actually conducts encryption). Thus, because that to which the terminal device **50** is connected is the GW server **20**, it can pass the check of the URL conducted by the terminal device **50**.

Next, the GW server **20** transmits the received SSL site certificate of the internal server **30** to the terminal device **50** (S**105**).

The terminal device **50** uses the received SSL site certificate to execute the same protocol procedure as a conventional SSL, generate key exchange information (S**106**), and transmit that key exchange information to the GW server **20** (S**107**).

When the GW server **20** receives the key exchange information, it transmits that key exchange information and the URL information received in S**101** to the internal server **30** (S**108**).

When the internal server **30** receives this information, it uses its own SSL site certificate and the received key exchange information to generate a common key (S**109**). The terminal device **50** also uses the SSL site certificate and the key exchange information to generate a common key using the same procedure as the internal server **30** (S**109'**). Thereafter, the terminal device **50** and the internal server **30** use this common key to transmit and receive encrypted packets to and from each other.

Then, the internal server **30** transmits a connection request packet with respect to the address "http://intra.abc.bar.co.jp" of the business server **40** described in the received URL information (S**110**). On the basis of this connection request packet, a session is established between the internal server **30** and the business server **40**, and the business server **40** transmits, to the internal server **30**, a packet including the data requested by the terminal device **50** (S**111**).

When the internal server **30** receives this packet, it determines whether or not absolute address information is included in the HTML expression data included in the packet (S**112**). If absolute address information is included, the internal server **30** determines whether or not the URL of the reference destination (access destination) described in that absolute address information is that of the corporate network **1** (S**113**). As a result of the determination, when absolute address information is included, the internal server **30** changes the absolute address information to via the GW server **20** (S**114**). Specifically, for example, when the absolute address information included in the HTML expression data is "http://intra2.abc.bar.co.jp/public/index.htm", the internal server **30** determines whether or not the URL of the reference destination is that of the corporate network **1** by comparing the domain of the server name, and when the URL is that of the corporate network **1**, the internal server **30** adds the URL "https://gw.foo.net" of the GW server **20** to which the internal server **30** is currently connected to the head of that URL to change the address to the absolute address information "https://gw.foo.net/http://intra2.abc.co.jp/public/index.htm". Because the internal server **30** changes the absolute address information in this manner, the terminal device **50** does not access the corporate network **1** directly but through the GW server **20**. Thus, the drawback that the corporate network **1** cannot be accessed from the terminal device **50** present on the Internet **2** can be eliminated.

Next, when absolute address information where the reference destination is that of the corporate network **1** is included in the packet received from the business server **40**, the internal server **30** uses the common key generated in S**109** to encrypt the packet whose absolute address information has been changed (S**115**) and transmits the encrypted packet to the GW server **20** (S**116**). Although not illustrated in FIG. **2**, when absolute address information where the reference destination is that of the corporate network **1** is not included in the packet, the internal server **30** encrypts, as is, the packet received from the business server **40** and transmits it to the GW server **20**.

Next, the GW server **20** transmits, as is, the packet to the terminal device **50** without decrypting the received packet (S**117**) The terminal device **50** uses the common key generated in S**109'** to decrypt the received packet and displays the result on the Web browser (S**118**).

According to the first embodiment, even if the reference destination of the absolute address information embedded in an HTML document provided by the business server **40** is an address on the corporate network **1**, the information is changed to address information via the GW server **20**. Thus, the terminal device **50** directly accesses the corporate network **1**, so that the access can be prevented from being denied.

Also, because the packet exchanged between the business server **40** and the terminal device **50** is encrypted by the common key generated between the internal server **30** and the terminal device **50**, the packet is not decrypted by the GW server **20** relaying the packet between the internal server **30** and the terminal device **50**. Thus, security can be improved because data that has inadvertently not been encrypted is not present on the GW server **20** that general users can access.

Moreover, when the absolute address information is changed by the internal server **30** as in the first embodiment, it is unnecessary to introduce special software in the terminal device **50**, so that time and effort for setting the terminal device **50** can be reduced.

The changing of the absolute address information may also be conducted by the terminal device rather than the internal server. In this case, even when numerous terminal devices are present, the changing of the address information is conducted by each terminal device, so that the processing burden on the internal server can be reduced.

Next, a case where the absolute address information is changed by the terminal device will be described as a second embodiment of the invention using the drawings.

In the second embodiment, the absolute address information is changed by the terminal device **50** by adding a function in advance to the Web browser incorporated in the terminal device **50**, or by storing a special Helper program (a program that processes designated mime-type data) in advance in the memory of the terminal device **50** and using the CPU disposed in the terminal device **50** to read that program in each case.

Here, in the second embodiment, the procedure where the terminal device **50** on the Internet **2** communicates with the business server **40** on the corporate network **1** will be described using FIG. **3**. S**201** to S**211** will be described briefly because they are the same as S**101** to S**111** of the first embodiment, and S**212** to S**218** will be described in detail.

First, the terminal device **50** transmits a connection request packet to the GW server **20** in order to initiate communication with the business server **40** (S**201**). The GW server **20** receives the connection request packet from the terminal device **50**, references the information following its own address in the URL information described in the packet, and identifies the address of the internal server **30** with respect to the business server **40** (S**202**). Then, the GW server **20** requests an SSL site certificate with respect to the identified internal server **30** (S**203**). The internal server **30** whose SSL site certificate has been requested transmits its own SSL site certificate to the GW server **20** (S**204**).

Next, the GW server **20** transmits the received SSL site certificate of the internal server **30** to the terminal device **50** (S**205**). The terminal device **50** uses the received SSL site certificate to generate key exchange information (S**206**) and transmits that key exchange information to the GW server **20** (S**207**) When the GW server **20** receives the key exchange information, it transmits that key exchange information and the URL information received in S**201** to the internal server **30** (S**208**).

When the internal server **30** receives this information, it uses its own SSL site certificate and the received key exchange information to generate a common key (S**209**). The terminal device **50** also uses the SSL site certificate and the key exchange information to generate a common key using the same procedure as the internal server **30** (S**209'**). Then, the internal server **30** transmits a connection request packet with respect to the address "http://intra.abc.bar.co.jp" of the business server **40** described in the received URL information (S**210**). On the basis of this connection request packet, a session is established between the internal server **30** and the business server **40**, and the business server **40** transmits, to the internal server **30**, a packet including the data requested by the terminal device **50** (S**211**).

Moreover, after the internal server **30** receives, from the business server **40**, the packet including the data requested by the terminal device **50**, the internal server **30** adds a predetermined mime type (e.g., "application/x-special-ssl-vpn") to the data portion of the received packet and encrypts the packet with the common key generated in S**209** (S**213**). Then, the internal server **30** transmits the encrypted packet to the GW server **20** (S**214**). The GW server **20** transmits, as is, the packet to the terminal device **50** without decrypting the packet received via the firewall **10** from the internal server **30**.

The terminal device **50** encrypts the received packet with the common key generated in S**209'** (S**216**), references the mime type added to the packet, starts up a Helper application corresponding to the mime type, and changes the absolute address information (S**217**).

The changing of the absolute address information by the Helper application is conducted as follows, for example.

Namely, in a case where the absolute address information is "http://intra2.abc.bar.co.jp/public/index.htm", first the terminal device **50** determines whether or not that URL is a URL present on the corporate network **1** by comparing the domain of the corporate network **1** with the domain of the server name to which the terminal device **50** initially tried to connect. When the URL is a URL present on the corporate network **1**, the terminal device **50** adds the URL "https://gw.foo.net" of the GW server **20** to which the terminal device **50** is currently connected to the head of the URL and changes the information to the absolute address information "https://gw.foo.net/http://intra2.abc.bar.co.jp/public/index. htm".

Then, the terminal device **50** displays, on the Web browser, the HTML data whose absolute address information has been changed in this manner (S**218**). Although not illustrated in FIG. **3**, when absolute address information where the reference destination is that of the corporate network **1** is not included in the packet, the terminal device **50** may display, as is on the Web browser, the HTML data included in the received packet without starting up the Helper application.

According to the second embodiment, the user designates the address corresponding to the absolute address information displayed on the browser, and the terminal device **50** is connected via the GW server **20** even when a connection request is conducted with respect to that address. Thus, the connection is prevented from being denied due to the connection being directly requested of the corporate network **1**.

In the second embodiment also, similar to the first embodiment, because the packet exchanged between the business server **40** and the terminal device **50** is encrypted by the common key generated between the internal server **30** and the terminal device **50**, the packet is not decrypted by the GW server **20** relaying the packet between the internal server **30** and the terminal device **50**. Thus, security can be improved because data that has inadvertently not been encrypted is not present on the GW server **20** that general users can access.

In the first or second embodiment, if it is necessary to authenticate the user when the terminal device **50** connects to the corporate network **1** via the GW server **20**, the GW server **20** may request user information, such as a user ID and password, with respect to the terminal device **50** when the terminal device **50** transmits the connection request packet to the GW server **20**. The user authentication may also be conducted by transferring user information to the internal server **30** from the GW server **20** using the Lightweight Directory Access Protocol (LDAP) or the like in the internal server **30**, without the user authentication being conducted by the GW server **20**. Moreover, the user authentication may also be conducted with a certificate in a public key encryption method rather than with a user ID and password.

Also, in the first and second embodiments, an example where a DMZ was constructed by one firewall **10** as shown in FIG. **1** was described, but the firewall is not limited to one. For example, as shown in FIG. **4**, the invention is also applicable to a case where a DMZ is constructed using two firewalls.

Moreover, the object of the invention may also be achieved by supplying, to a system or device, a storage medium in which is stored a software program that realizes the functions of the above embodiments, so that a computer of the system or device (e.g., a CPU or an MPU) reads and executes the program code stored in the storage medium.

In this case, the program code itself read from the storage medium realizes the functions of the above embodiments, and the storage medium in which the program code is stored configures the invention. As the storage medium for supplying the program code, a floppy disk, a hard disk, an optical disk, an optical-magnetic disk, a CD-ROM, a CD-R, magnetic tape, a nonvolatile memory card, or a ROM can be used.

The invention also includes cases where, rather than the functions of the above embodiments being realized as a result of the program code that the computer has read being executed, an OS (operating system) running on the computer conducts part or all of the actual processing on the basis of an instruction in the program code, so that the functions of the above embodiments are realized by that processing.

Moreover, the invention also includes cases where, after the program code read from the storage medium is written in a memory disposed in a function expansion board inserted into the computer or function expansion unit connected to the computer, a CPU disposed in the function expansion board or function expansion unit conducts part or all of the actual processing on the basis of an instruction in the program code, so that the functions of the above embodiments are realized by that processing.

According to one aspect of the network system pertaining to the invention, the internal server includes determining unit that determines whether or not absolute address information for accessing a communication device present on the internal network is included in the packet received by the receiving unit, and changing unit that changes the absolute address information to via the external server when absolute address information is included, and the encrypting unit conducts, with respect to the packet whose absolute address information has been changed, encryption that can be decrypted only by the reception-destination terminal device when absolute address information is included.

According to this invention, when absolute address information for accessing a communication device present on the internal network is included in the received packet, the internal server changes the absolute address information to via the external server, and then encrypts and transmits the packet to the external server. Thus, when the terminal device on the external network receives the packet from the corporate network and accesses a communication device present on the internal network on the basis of the absolute address information included in that packet, the terminal device accesses the communication device via the external server, so that the terminal device directly accesses the communication device on the internal network, whereby access can be prevented from being denied as a result of the settings of the firewall.

According to an aspect of the network system pertaining to the invention, the terminal device includes receiving unit that receives the packet that the application server has transmitted, determining unit that determines whether or not absolute address information for accessing a communication device present on the internal network is included in the packet received by the receiving unit, and changing unit that changes the absolute address information to via the external server when absolute address information is included.

According to this invention, when the terminal device receives the packet including the absolute address information for accessing a communication device present on the internal network, the terminal device changes that absolute address information to via the external server. Thus, when the terminal device on the external network receives the packet from the corporate network and accesses a communication device present on the internal network on the basis of the absolute address information included in that packet, the terminal device accesses the communication device via the external server. Thus, the terminal device directly accesses the communication device on the internal network, whereby access can be prevented from being denied as a result of the settings of the firewall.

While illustrative and presently embodiments of the present invention have been described in detail herein, it is to be understood that the inventive concepts may be otherwise variously embodied and employed and that the appended claims are intended to be construed to include such variations except insofar as limited by the prior art.

The entire disclosures of Japanese Patent Application No. 2004-227617 filed on Aug. 4, 2004 including specification, claims, drawings, and abstract is incorporated herein by reference.

What is claimed is:

1. A network system, comprising:

a firewall that connects an external network and an internal network;

a terminal device being provided on the external network;

an application server being provided on the internal network, the application server that provides data to the terminal device based on a request from the terminal device; and

an external server being provided on a DMZ of the firewall or on the external network, the external server configured to receive a request from the terminal device to connect to the application server and relay communication between the terminal device and the application server through an internal server;

the internal server being provided on the internal network, the internal configured to relay communication between the external server and the application server,

the internal server further, comprising:

a receiving unit that receives a packet for the terminal device from the application server;

an encrypting unit that encrypts the packet in such a manner that an encrypted packet is able to be decrypted only by the terminal device; and

a transmitting unit that transmits the encrypted packet to the external server via the firewall,

the external server further comprising:

a receiving unit that receives the packet encrypted by the internal server; and

a transmitting unit that transmits the received encrypted packet to the terminal device,

wherein

decryption of the received encrypted packet is suppressed in the external server by changing an absolute address information for accessing a communication device,

communication between the external server and the internal server is permitted when a session is established based on a connection request from the internal server to connect to the external server, and

the external server relays the request from the terminal device for connection to the application server through the internal server as a response to the connection request from the internal server,

wherein the internal server or the terminal device further comprises:

a determining unit that determines whether or not the packet received by the receiving unit contains the absolute address information for accessing the communication device, the communication device including the application server or a database server connected to the internal network, the database server providing additional information to the terminal device, and

a changing unit that changes the absolute address information to address information via the external server when absolute address information is contained in the packet received by the receiving unit.

2. The network system according to claim **1**,

wherein when the internal server comprises the determining unit and the changing unit,

the encrypting unit encrypts the packet whose address information is changed by the changing unit, in such a manner that an encrypted packet is able to be decrypted only by the terminal device.

3. The network system according to claim **1**, the terminal device further comprising:

a receiving unit that receives a packet transmitted from the application server.

4. An internal server being provided on an internal network, the internal server communicating with an external server via a firewall connected between an external network and the internal network, the external server being provided on a DMZ of the firewall or on the external network, the internal server comprising:

a receiving unit that receives a packet for a terminal device from an application server, the terminal device being provided on the external network;

a determining unit that determines whether or not the packet received by the receiving unit contains absolute address information for accessing a communication device, the communication device being provided on the internal network and including the application server or a database server, the database server providing additional information to the terminal device; and

a changing unit that changes the absolute address information to address information via the external server when the absolute address information is contained in the packet received by the receiving unit,

an encrypting unit that encrypts the packet in such a manner that an encrypted packet is able to be decrypted only by the terminal device; and

a transmitting unit that transmits the encrypted packet to the external server,

wherein

decryption of the received encrypted packet is suppressed in the external server by changing the absolute address information,

communication between the external server and the internal server is permitted when a session is established based on a connection request from the internal server to connect to the external server, and

the internal server relays a request from the terminal device for connection to the application server through the external server as a response to the connection request.

5. The internal server according to claim **4**,

wherein the encrypting encrypts the packet whose address information is changed by the changing unit, in such a manner that an encrypted packet is able to be decrypted only by the terminal device when the absolute address information is contained.

6. A computer-readable storage medium that stores a program for controlling an internal server by use of a computer, the internal server being present on an internal network that communicates, via a firewall connected between an external network and an internal network, with an external server present on a DMZ of the firewall or on the external network, with communication with the external server being permitted only by a session established on the basis of a request from the internal server to connect to the external server, due to access restriction settings of the firewall, and with the internal server relaying to an application server on the internal server a request from a terminal device on the external network to connect to the application server relayed via the external server, in response to the internal server's request to connect to the external server, the program drives the internal server to execute under control of the computer comprising:

receiving a packet destined for the terminal device on the external network from the application server;

determining whether or not the received packet contains absolute address information for accessing a communication device present on the internal network;

changing the absolute address information to address information via the external server when the absolute address information is contained;

encrypting the packet whose address information is changed by the changing unit, in such a manner that an encrypted packet is able to be decrypted only by the terminal device when the absolute address information is not contained; and

transmitting the encrypted packet to the external server, wherein decryption of the encrypted packet is suppressed in the external server by changing the absolute address information.

7. A packet relay method for relay processing of a packet on a network system, the network system including a firewall connected between an external network and an internal network; a terminal device present on the external network; an

application server present on the internal network, the application server that provides data to the terminal device in response to a request from the terminal device; an external server present on a DMZ of the firewall or on the external network, the external server that receives the request from the terminal device to connect to the application server and relays communication between the terminal device and the application server; and an internal server present on the internal network, the internal server that relays communication between the external server and the application server, with communication between the external server and the internal server being permitted only by a session established on the basis of a connection request from the internal server to connect to the external server, and with the external server relaying the request from the terminal device for connection to the application server as a response to the connection request from the internal server, the packet relay method comprising:

receiving by the internal server a packet for the terminal device from the application server;

determining by the internal server whether or not the packet received contains absolute address information for accessing a communication device present on the internal network;

changing the absolute address information to address information via the external server when the absolute address information is contained;

encrypting the received packet to be decrypted by only the terminal device after having changed the absolute address information when the absolute address information is contained, or without any change when the absolute address information is not contained;

transmitting by the internal server the encrypted packet to the external server via the firewall;

receiving by the external server the packet encrypted by the internal server; and

transmitting by the external server intact the received encrypted packet to the terminal device, wherein decryption of the received encrypted packet is suppressed in the external server by changing the absolute address information.

8. The network system according **1**, wherein the external server requests the terminal device to provide user information, and the external server establishes connection to the terminal device.

9. A network system comprising:

an internal network having an internal server;

an external network having a terminal device;

a gateway server relaying data between the internal server and the terminal device; and

a firewall that connects the internal network to the external network,

wherein the internal server determines whether or not received data contains absolute address information, and changes absolute address information to address information which the terminal device can access when the received data has the absolute address information,

wherein the internal server transmits the data to the terminal device via the gateway server and the data is encrypted by the internal server in such a manner that an encrypted packet is able to be decrypted only by the terminal device, and

wherein decryption of the encrypted packet is suppressed in the gateway server by changing the absolute address information.

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